

WHAT IS CLAIMED IS:

1. An ultrasonic diagnostic apparatus for scanning a subject with ultrasonic pulses, the apparatus comprising:

a transmission means for transmitting the ultrasonic pulses to each scanning line of the scan a plurality of times;

a receiving means for receiving an ultrasonic echo signal returned when the ultrasonic pulses are reflected or scattered in the subject, and acquiring an electrical receiving signal that corresponds to the ultrasonic echo signal;

a filter means for applying filter processing with characteristics that are different depending on a respective one of the plurality of receiving signals each corresponding to the ultrasonic echo signal;

a synthesizing means for synthesizing the plurality of receiving signals processed by this filter means;

a generating means for generating an image using the receiving signals synthesized by this synthesizing means; and

a display means for displaying the image generated by this generating means.

2. The ultrasonic diagnostic apparatus as claimed in claim 1, wherein the ultrasonic pulses transmitted by the transmission means are different from each other at its center frequency every time repeated transmission relevant to each scanning line is carried out.

3. The ultrasonic diagnostic apparatus as claimed in claim 1,

wherein the ultrasonic pulses transmitted by the transmission means has a narrow frequency bandwidth to an extent such that the signal component corresponding to the harmonic component of the ultrasonic pulse can be easily separated from the signal component that corresponds to the fundamental component.

4. The ultrasonic diagnostic apparatus as claimed in claim 1, wherein the filter means is a means for sampling from the receiving signal the signal component corresponding to the harmonic component of the ultrasonic pulse.

5. The ultrasonic diagnostic apparatus as claimed in claim 4, wherein a signal component corresponding to the harmonic component, synthesized by the synthesizing means has a wider bandwidth than that of a harmonic component obtained by one transmission / reception and filter processing of the ultrasonic pulses.

6. The ultrasonic diagnostic apparatus as claimed in claim 4, wherein the harmonic component is a signal component that corresponds to a sub-harmonic component of the ultrasonic pulses generated by the non-linear behavior of an ultrasonic contrast medium administered to the subject.

7. The ultrasonic diagnostic apparatus as claimed in claim 4, wherein the filter changes filter characteristics of the filter processing according to the depth in said each scanning line direction, and comprises

a means for executing filter processing with characteristics in which the fundamental component of the ultrasonic pulses remains positively in a predetermined amount.

8. The ultrasonic diagnostic apparatus as claimed in claim 1, wherein a synthesizing process carried out by the synthesizing means is a process for adding the plurality of receiving signals.

9. The ultrasonic diagnostic apparatus as claimed in claim 1, further comprising means for changing at least one parameter of the center frequency and frequency bandwidth of the ultrasonic pulses every time the ultrasonic pulses are repeatedly transmitted to such each scanning line a plurality of times, the amplitude of the ultrasonic pulses, aperture during transmission of the ultrasonic pulses, a focus when the ultrasonic pulses are focused in a beam shape, and a receiving gain relevant to the receiving signal.

10. The ultrasonic diagnostic apparatus as claimed in claim 1, wherein the ultrasonic pulses transmitted by the transmission means has a frequency bandwidth at which a signal component corresponding to the harmonic component of the ultrasonic pulse in the receiving signal and a signal component corresponding to the fundamental component are partially superimposed on each other, and wherein the filter means is a means for sampling a signal component in a frequency range free of superimposition on the fundamental component on spectra from the receiving signal, of the signal components each corresponding to the

harmonic component, for said each transmission.

11. The ultrasonic diagnostic apparatus as claimed in claim 1, wherein the transmission means may be a means for changing the count of plural transmissions of the ultrasonic pulses and the level of the center frequency in each transmission of the ultrasonic pulses so that physiological attenuation is corrected at the receiving signal synthesized by the synthesizing means.

12. An ultrasonic diagnostic apparatus for scanning a subject with ultrasonic pulses, thereby acquiring a harmonic image, said apparatus comprising:

a transmission means for transmitting the ultrasonic pulses having narrow-bandwidth spectrum characteristics a plurality of times to an extent such that a signal component corresponding to a harmonic component can be easily separated from a signal component that corresponds to its fundamental component with respect to each scanning line of the scan;

a receive processing means for receiving the echo signal of the ultrasonic pulses over the plural times of transmissions, thereby forming a harmonic signal having a wide-bandwidth spectrum characteristics; and

an image generating means for generating the harmonic image from this harmonic signal.

13. An ultrasonic imaging method for scanning ultrasonic pulses to be transmitted to a subject, acquiring an electrical receiving signal that

corresponds to an ultrasonic echo returned when the ultrasonic pulses are reflected or scattered in the subject, and acquiring an image in a scan region from the receiving signal, said method comprising the steps of:

executing transmission of ultrasonic pulses, receiving of an echo signal, and acquisition of a receiving signal a plurality of times for each scanning line of a scan;

applying filter processing with characteristics that are different depending on a respective one of a plurality of receiving signals to be received, to each scanning line;

synthesizing the plurality of processed receiving signals are synthesized with each other;

generating the image by using the synthesized receiving signal;  
and

displaying the image.

14. The ultrasonic imaging method as claimed in claim 13, wherein the transmitted ultrasonic pulses are different from each other at its center frequency every time transmission is repeatedly carried out for each scanning line.

15. The ultrasonic diagnostic apparatus as claimed in claim 13, wherein the transmitted ultrasonic pulse has a narrow frequency bandwidth to an extent such that a signal component corresponding to the harmonic component of the ultrasonic pulses in a receiving signal can be easily separated from a signal component corresponding to its fundamental component.

16. The ultrasonic diagnostic apparatus as claimed in claim 13, wherein filter processing is a process for sampling from a receiving signal a signal component that corresponds to the harmonic component of ultrasonic pulses every transmission.

17. The ultrasonic diagnostic apparatus as claimed in claim 16, wherein a signal component corresponding to the harmonic component synthesized has a wider bandwidth than that of the harmonic component obtained by one transmission / receiving and filtering of the ultrasonic pulses.

18. The ultrasonic diagnostic apparatus as claimed in claim 13, wherein the harmonic component is a second harmonic component of ultrasonic pulses generated by the non-linearity of physiological tissues of a subject or a second harmonic component of ultrasonic pulses generated by the non-linear behavior of the ultrasonic contrast medium administered to the non-linearity of the physiological tissues of the subject.

19. The ultrasonic diagnostic apparatus as claimed in claim 13, further comprising the step of changing at least one parameter of at least one of the center frequency and frequency bandwidth of the ultrasonic pulses; a bandwidth of the ultrasonic pulses; aperture during transmission of the ultrasonic pulses; a focus when the ultrasonic pulses are focused in a beam shape; and a receiving gain relevant to the receiving signal every

time the ultrasonic pulses are repeatedly transmitted to such each scanning line a plurality of times.

20. An ultrasonic diagnostic apparatus for scanning a subject with ultrasonic pulses, thereby acquiring a harmonic image, said apparatus comprising:

a transmission means for transmitting ultrasonic pulses having their two polarities inverted each other for each scanning line in which ultrasonic pulses are to be scanned;

a receiving means for acquiring an electrical receiving signal that corresponds to a ultrasonic echo returned when the ultrasonic pulses are reflected or scattered in the subject every such transmission;

a synthesizing means for synthesizing the plurality of receiving signals so as to widen the bandwidth of a harmonic component relevant to the fundamental component of the ultrasonic pulses; and

an image generating means for generating a harmonic image from the harmonic component widened in bandwidth by the synthesizing means.

21. The ultrasonic diagnostic apparatus as claimed in claim 20, wherein the synthesizing means comprises: a means for adding a receiving signal with its inverted polarities in the fundamental component of the ultrasonic pulses, thereby sampling the harmonic component; and a means for synthesizing the thus sampled harmonic component.